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# DETECTION OF ATMOSPHERIC $NH_3$ FROM IASI SATELLITE AND ITS VALIDATION USING CHEMICAL TRANSPORT MODEL OVER INDIAN REGION: A REVIEW

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***ABSTRACT***

***Atmospheric ammonia ($NH_3$) has great environmental implications due to its important role in ecosystem and global nitrogen cycle, as well as contribution to secondary particle formation. Ammonia ($NH_3$) emissions in the atmosphere have increased substantially over the past decades, largely because of intensive use of fertilizers. It has been increasing over a South Asia and particularly in India and China. It has a negative impact to the environment and the public health. Measurement of $NH_3$ distribution lies generally on model calculation, due to the limited availability of ground-based measurements. Gaseous ammonia $NH_3$ is the most abundant alkaline gas present in the atmosphere. It also contributes to the total reactive nitrogen. The objective of this study is to determine the $NH_3$ emission and its distribution over India and China. This study will give the hotspot areas of $NH_3$ emissions over India and China. Study will also include temporal and spatial analysis of $NH_3$ measurement which will give season wise distribution of ammonia over an Indian region and will highlight which season is particularly contributing more to its concentration. There are various sources which contribute to the emission of ammonia. This study will discuss source contribution for ammonia emission. Particularly five different sectors/sources have been considered for the emissions. This includes agricultural, industrial, residential, transport and energy sectors. Hence, by analysing this results the prominent source which contributes to the emissions can be highlighted.***

***KEYWORDS: Atmosphere, Ammonia , Emission, Source & Impact***

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Review Article

## INTRODUCTION

Ammonia plays an important role in many atmospheric processes. Important N gases are emitted by human activities from various different sources which includes oxides of nitrogen (NOx), nitrous oxide (NO) and $NH_3$. The sources from where the ammonia is emitted includes volatilization from animal waste, synthetic fertilizers, biomass burning(including forest fires) ,losses from soils under native vegetation and agricultural crops, emissions from human excreta and fossil fuel combustion. The need to sustain food production to meet the demand for growing populations of India is leading to the increased agricultural emissions of $NH_3$ with perturbations of the global biogeochemical $NH_3$ cycle. The Indo Gangetic Plains (IGP) straddling the north eastern parts of India near the foot hills of the Himalayas is one of the most densely populated regions on the globe, with consequent large anthropogenic emissions. As this plain is mainly covered by agricultural area, it strongly contributes to the emission of atmospheric $NH_3$. In particular, the use of traditional bio fuels in the rural areas

along the plains leading to strong emissions of various pollutants. It is also a region with many power plants and industries, and the recent economic growth of India has led to significant increase in industrial emissions. Atmospheric acidic pollutants (sulphuric, nitric, and hydrochloric acids) in the atmosphere reacts very rapidly with ammonia present at high concentration resulting in the formation of ammonium salt aerosols which increases the opacity of the atmosphere locally. Ammonia catalyzes the atmospheric oxidation of sulfur dioxide to sulfur trioxide. The ammonium salts formed are the main components of smog aerosols and thus affect the opacity of the atmosphere and the earth radiation budget.

## LITERATURE REVIEW

**M. Van Damme, L. Clarisse, C. L. Heald, D. Hurtmans, Y. Ngadi, C. Clerbaux, A. J. Dolman, J. W. Erisman, and P. F. Coheur (2014)** has discussed global distributions, time series and error characterization of atmospheric ammonia ($NH_3$) from IASI satellite observations. They have described an improved method for the retrieval of $NH_3$ total column concentrations from IASI spectra, with improved sensitivity and near real-time applicability. Export of $NH_3$, principally on the west coast of Africa and around India and Mexico, have been observed for the first time. They have shown with the example of eastern Asia that the improved retrieval method also detects fine patterns of emissions on the regional scale. Seasonal cycles have been studied from the time series, separately for the Northern and Southern Hemispheres. The seasonality was shown to be more pronounced in the Northern Hemisphere, with peak columns in spring and summer.

**M. Van Damme, L. Clarisse, E. Dammers, X. Liu, and J. B. Nowak (2015)** have discussed validation of $NH_3$ measurements using IASI satellite. They observed IASI satellite measurements of $NH_3$ are consistent with the available data sets used in their study. They presented only the first steps to validate IASI-NH3 columns. The comparison between IASI-derived concentrations and the surface concentrations measured locally was assessed using linear regressions. In addition to the comparison with ground-based measurements, they also discussed a comparison of the IASI-derived VMR to vertically resolved CIMS measurements from the NOAA WP-3D airplane during the CalNex campaign in 2010.

**M. Van Damme, R. J.Wichink Kruit, M. Schaap, L. Clarisse, C. Clerbaux, P.-F. Coheur, E. Dammers, A. J. Dolman, and J.W. Erisman (2014)** have evaluated 4 years of atmospheric ammonia ($NH_3$) over Europe using IASI satellite observations and LOTOS-EUROS model results. They introduced a novel methodology to compare unconstrained satellite retrievals of $NH_3$ with model results, which accounts for measurement uncertainty. They presented a first detailed comparison between IASI satellite observations and LOTOS-EUROS model results over Europe. Modeled and measured distributions both revealed the same agricultural source areas in Europe: the Po Valley, the North Western Europe, and the Ebro Valley.

**Sailesh N. Behera, Mukesh Sharma, Viney P. Aneja and Rajasekhar Balasubramanian(2013)** have discussed Ammonia in the atmosphere and reviewed on emission sources, atmospheric chemistry and deposition on terrestrial bodies. They concluded the major sources of atmospheric $NH_3$ are agricultural activities and animal feedlot operations, followed by biomass burning (including forest fires) and, to a lesser extent, fossil fuel combustion.

**C. A. Skjoth and C. Geels (2013)** have discussed the effect of climate and climate change on ammonia emissions in Europe. They presented a dynamical method for modelling temporal and geographical variations in ammonia emissions in regional-scale chemistry transport models (CTMs) and chemistry climate models (CCMs).

**Jean J. Renard , Sheryl E. Calidonna and Michael V. Henley(2004)** have discussed the Fate of ammonia in the atmosphere and reviewed for applicability to hazardous releases. They have been reviewed the physical and chemical mechanisms responsible for the removal of ammonia from the atmosphere. Capture by atmospheric moisture (clouds, rain, fog), surface water (rivers, lakes, seas), and deposition on vegetation and soil constituted the main pathways for ammonia removal from the troposphere.

**S. K. Sharma, R. C. Harit, V. Kumar,T. K. Mandal and H. Pathak (2014)** have discussed Ammonia Emission from Rice–Wheat Cropping System in Subtropical Soil of India. Ammonia ($NH_3$) emission from rice (July–October) and wheat (November–April) cropping system was measured using the chemiluminescence method at the subtropical agricultural land of Delhi, India during 2009–2010 and 2010–2011. They measured about 9.0 % of the applied fertilizer N was lost as $NH_3$ during the wheat crop (2009–2010 and 2010–2011), whereas 8.6 % of the applied N was loss as $NH_3$ during rice crop (2010 and 2011).

**Lieven Clarisse, Cathy Clerbaux, Frank Dentener, Daniel Hurtmans and Pierre-François Coheur (2014)** have discussed Global ammonia distribution derived from infrared satellite observations.

S K Sharma, M Saxena, T Saud, S Korpole, and T K Mandal (2012) have measured $NH_3$, NO, $NO_2$ and related particulates at urban sites of Indo Gangetic Plain (IGP) of India. They presented variability and concentration of ambient $NH_3$, NO and $NO_2$ along with particulate matter ($PM_{10}$) at urban sites of Chandigarh and Delhi of IGP of India (Dec 2010 - Mar 2011).

**I E Galbally (1975)** have measured emission of nitrogen and ammonia in the northern hemisphere from the Earth's surface which have upper limits of $3 \times 10^{13}$ g(N)/year and $13 \times 10^{13}$ g(N)/year respectively. He concluded that nitrate aerosol and deposition probably have significantly increased during the last few decades due to increased fossil fuel consumption. The upper limit of the rate of natural emission from the earth's surface is estimated from measurements of the mixing ratio of the gas in "background" Surface air and the bulk Vertical eddy diffusivity of the planetary boundary layer.

## SUMMARY OF LITERATURE

After thorough evaluation of the related literature, it can be revealed that there is very less work studied on atmospheric ammonia over Indian Region. Mozart model which is a global chemical transport model can be used for measuring the ammonia over an Indian region. This chemical model can be validated through the IASI satellite. IASI satellite data sets can be downloaded and can be used for validation by going through the related literature. Various software applications can be used for graphical representation of model data. Major sources of ammonia and its fate can be determined by this literature study. Past results outcome of different models can be studied. The review empowers researchers to maximize its work on further study of atmospheric ammonia, its effects and validation.

## CONCLUSIONS

Above mentioned literature summarised that Atmospheric ammonia is a major component contributing to the troposphere aerosol formation. It can be measured by global chemical transport model and further validation using IASI satellite. Atmospheric ammonia contributes to visibility reduction and aerosol formation

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